Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Unlicensed Use of the 6 GHz Band	)	ET Docket No. 18-295
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183

COMMENTS OF MICROSOFT CORPORATION

Paula Boyd, Senior Director
U.S. Government and Regulatory Affairs

Michael Daum
Director, Technology Policy
Privacy and Regulatory Affairs

901 K Street, N.W., 11th Floor
Washington, DC 20001
202-263-5900

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SUMMARY

Microsoft applauds the Commission for recognizing the importance of unlicensed spectrum uses, such as Wi-Fi, to the U.S. economy, for further recognizing that within a few years there will be insufficient Wi-Fi capacity to meet demand if additional spectrum is not made available, and for proposing rules to ensure that such spectrum is made available.

The availability of sufficient spectrum for unlicensed services, particularly Wi-Fi, is critical to supporting "America's [insatiable] appetite for wireless broadband connections …."[1] High-throughput Wi-Fi is essential to the American economy. Not only is increasing the supply of unlicensed spectrum for Wi-Fi an imperative, the unlicensed spectrum needs to be in sufficiently large blocks to support 80 and 160 megahertz channel sizes that enable high-throughput applications and cloud-based services. The 6 GHz band is ideally suited to accommodate the demand for additional spectrum for Wi-Fi.

Microsoft supports the Commission's proposal to authorize low-power indoor ("LPI") operations in the U-NII-6 and U-NII-8 frequency bands. Additionally, because the risk of harmful interference to incumbent operations is extremely low and the direct and indirect economic benefits to society are high, Microsoft urges the Commission to extend authorization of LPI operations to the U-NII-5 and U-NII-7 frequency bands.

Microsoft disagrees with the Commission's proposal to limit the power of an LPI client device to 63 mW. Instead, the Commission should permit LPI client devices to operate at the same power level as the controlling LPI access point. If enacted, the Commission's proposal would, in effect, limit enterprise applications such as remote

[1] *In the Matter of Unlicensed Use of the 6 GHz Band*, Notice of Proposed Rulemaking, ET Docket No. 18-295, FCC 18-147 (rel. Oct. 24, 2018) at ¶ 4.

monitoring where the uplink throughput is as important as the downlink throughput. As a result, for these applications the useful coverage area of any LPI access point would be substantially reduced, thereby requiring more access points to be deployed to cover the same area and significantly increasing the cost of deployment.

Microsoft strongly supports the Commission's proposal to authorize standard-power access points to operate in the U-NII-5 and U-NII-7 bands. Microsoft proposes that the Commission authorize standard-power access points to operate in the lower 100 megahertz of the U-NII-8 band (6875 - 6975 MHz) outside of the areas licensed for Broadcast Auxiliary Service ("BAS") and Cable Television Relay Service ("CARS") by requiring Local Television Transmission Service ("LTTS") to operate within BAS/CARS license areas in the 6875 - 6975 MHz band and moving the lower Low Power Auxiliary Service channel in the U-NII-8 band from 6875 - 6900 MHz to 7075 - 7100 Hz. Standard-power operations would be subject to Automated Frequency Coordination ("AFC").

Microsoft opposes a maximum installation height for outdoor standard-power access points. The height of an outdoor unit should be factored into the calculations made by the AFC system regarding available frequencies and maximum power levels. The Commission should permit, but not mandate, professional installation.

Microsoft strongly believes that the Commission's AFC regulations must protect incumbents from harmful interference, but that the Commission should grant maximum flexibility to AFC Operators. The Commission should permit both centralized and decentralized AFC models. Depending on the use case, the location of the data repository and the calculation engine functions can range from being built into the

standard-power access point itself or residing in the cloud. Further, Microsoft proposes that:

- The AFC be capable of calculating, and permitted to provide, information on the maximum power for each available frequency.
- The AFC Operator may charge a fee.
- There is no need for AFCs to synchronize or coordinate amongst themselves as the periodic updates from the Commission's ULS and other databases serve this purpose.
- Some centralized AFC models may benefit from an industry group such as the Internet Engineering Task Force or IEEE creating a voluntary standard for a common interface between standard-power access points and AFCs. Decentralized AFC models do not require this.
- Standard-power access points (and associated client devices) should be certified as any Part 15 device.
- A standard-power access point should be certified with its controlling AFC as a pair. An AFC could be seen as a component of the access point or a separate certifiable entity, depending on the use case.

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COMMENTS OF MICROSOFT CORPORATION

Microsoft Corporation ("Microsoft") hereby submits its Comments in response to the Notice of Proposed Rulemaking ("NPRM") in the above-captioned proceedings regarding unlicensed use of the 5.925 – 7.125 GHz band ("6 GHz" band).[1] Microsoft applauds the Commission for recognizing the importance of unlicensed spectrum uses, such as Wi-Fi, to the U.S. economy, for further recognizing that within a few years there will be insufficient Wi-Fi capacity to meet demand if additional spectrum is not made available, and for proposing rules to ensure that such spectrum is made available. As a leading provider of cloud services, Microsoft fully recognizes that its customers rely on high-throughput Wi-Fi to connect to the backbone network. As a result, Microsoft is acutely aware of the growing shortage of unlicensed spectrum for Wi-Fi, and the urgent need to make available more unlicensed spectrum for Wi-Fi.

Microsoft is a member of the 6 GHz Unlicensed Spectrum Coalition ("6USC"), and Microsoft has signed on to the 6USC Comments. The purpose of these Comments is to highlight the areas of the NPRM that are of most importance to Microsoft. They are: (1) authorizing low-power indoor ("LPI") operations across the entire 6 GHz band; (2) authorizing LPI client devices

[1] *In the Matter of Unlicensed Use of the 6 GHz Band*, Notice of Proposed Rulemaking, ET Docket No. 18-295, FCC 18-147 (rel. Oct. 24, 2018); *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373 (2017) ("Mid Band NOI").

at the same radiated power level as LPI access points; (3) authorizing standard-power access points to operate in the lower 100 megahertz of the U-NII-8 band outside of areas licensed to the Broadcast Auxiliary Service ("BAS") or Cable Television Relay Service ("CARS"); and (4) granting flexibility in how the Automated Frequency Coordination ("AFC") is implemented as long as incumbent operations are protected. Where appropriate, we will refer to the 6USC Comments.

I. PROVIDING ADDITIONAL SPECTRUM FOR 80 AND 160 MEGAHERTZ WI-FI CHANNELS IS ESSENTIAL TO SERVING CONSUMERS AND ENTERPRISES

The availability of sufficient spectrum for unlicensed services, particularly Wi-Fi, is critical to supporting "America's [insatiable] appetite for wireless broadband connections …."[2] High-throughput Wi-Fi is essential to the American economy. As the Commission recognized, "[un]licensed Wi-Fi wireless routers provide the crucial link between many users' devices and the Internet."[3] The Commission further recognized that:

> Wi-Fi, in particular, has become *indispensable* for providing high data rate local area network connections for smart phones, tablets, mobile computers, and other devices to interconnect and access the Internet. Wi-Fi has also enabled the offloading of data from commercial wireless networks as consumers increase use of smart phones for applications such as streaming video and gaming, and it has provided a means for devices throughout the home to wirelessly interconnect.[4]

The meteoric growth in Internet usage, particularly via portable devices, has resulted in the "insatiable" demand for Wi-Fi – and the spectrum to support Wi-Fi. Cisco's 2018 Visual Networking Index ("VNI") analysis shows that fixed/Wi-Fi

[2] NPRM at ¶ 4.

[3] Id. at ¶ 5.

[4] Id. at ¶ 3 (emphasis added).

constituted 50.4% of total Internet traffic in 2017, and will grow to 56.6% by 2022.[5] Further, the Cisco VNI analysis predicts that fixed Wi-Fi from mobile devices will grow at a 53% compound annual rate from 2017 to 2022.[6] There is expected to be additional demand for unlicensed spectrum as 5G services, incorporating both licensed and unlicensed spectrum, ramp up over the next few years.

The current supply of mid-band spectrum available to Wi-Fi is limited to the 2.4 GHz band (2400 - 2483 MHz), U-NII-1 band (5150 - 5250 MHz), U-NII-2A band (5250 - 5350 MHz), U-NII-2C band (5470 - 5725 MHz), and the U-NII-3 band (5725 - 5850 MHz). Wi-Fi operations in the 2.4 GHz band experience congestion in many locations during "busy hours." Wi-Fi operations in the U-NII-2A and U-NII-2C bands require Dynamic Frequency Selection to enable sharing with military radars, which substantially increases its cost and limits its utility for certain important Wi-Fi use cases. For this reason, the vast majority of Wi-Fi usage in the 5 GHz band is limited to the U-NII-1 and U-NII-3 bands.

Not only is increasing the supply of unlicensed spectrum for Wi-Fi an imperative, the unlicensed spectrum needs to be in sufficiently large blocks to support 80 and 160 megahertz channel sizes that enable high-throughput applications and cloud-based services. The availability of these large capacity Wi-Fi channels becomes more important as the speed of the Internet service to the residence or enterprise increases. To fully leverage the benefits of a bigger data pipe, the wireless connection from the home

[5] Cisco Systems, Inc., Cisco Visual Networking Index, Complete Forecast Highlights Tool, North America, United States, Wired Wi-Fi and Mobile Growth (2018), https://www.cisco.com/c/dam/m/en_us/solutions/service-provider/vni-forecast-highlights/pdf/United_States_2022_Forecast_Highlights.pdf ("Cisco VNI"), last visited Feb. 12, 2019.

[6] Id.

access point to the Wi-Fi client device must be at least as fast as the connection coming into the residence. Otherwise, the wireless connection between the Wi-Fi access point and the client device may become the system bottleneck. High throughput, low-latency cloud-based services such as on-line gaming and augmented reality will greatly benefit from the availability of multiple wide channels that can penetrate one or two walls. A similar argument can be made for the benefits of having multiple 80 and 160 megahertz Wi-Fi channels available in the enterprise space, particularly for small businesses where cloud access to critical business resources has become the norm. For these reasons, Microsoft urges the Commission to authorize new shared spectrum that can be used for high capacity Wi-Fi channels.

As we stated in our Comments filed in response to the NOI, the 6 GHz band is ideally suited to accommodate the demand for additional spectrum for Wi-Fi.[7] First, the 6 GHz band is contiguous with the 5 GHz band, and thus, Wi-Fi chip and device manufacturers can leverage common technologies and economies of scale to develop and deploy Wi-Fi devices that can operate across both bands. Second, the 6 GHz band offers contiguous spectrum blocks sufficient to accommodate multiple 80 and 160 megahertz channels. The next generation of Wi-Fi, based on IEEE 802.11ax, is designed to operate on these wide channel blocks, and can support throughput greater than 1 Gbps, which will facilitate a host of high-throughput applications and on-line services.

[7] *See* Microsoft Comments to Mid-Band NOI at 10.

II. THE COMMISSION SHOULD AUTHORIZE LOW POWER INDOOR OPERATIONS ACROSS THE ENTIRE 6 GHZ BAND

Microsoft supports the Commission's proposal to authorize LPI operations in the U-NII-6 and U-NII-8 frequency bands. Additionally, because the risk of harmful interference to incumbent operations is extremely low and the direct and indirect economic benefits to society are high, Microsoft urges the Commission to extend authorization of LPI to the U-NII-5 and U-NII-7 frequency bands.

Having harmonized rules for LPI devices that operate across the entire 6 GHz band will support the deployment of devices that can take advantage of multiple high-throughput 80 and 160 megahertz channels. As industry has not settled on a 6 GHz band plan, the U-NII-6 band at best can support one 80 megahertz channel. Unless the proposed guard band between the U-NII-4 and U-NII-5 bands increases significantly, the U-NII-8 band will likely support one 160 megahertz (or two 80 megahertz) channels. This means that if LPI devices -- the class of devices that most consumers will purchase -- can only operate in the U-NII-6 and U-NII-8 bands, there will be at most one 160 megahertz wide channel and one 80 megahertz channel, or three 80 megahertz channels. If the Commission authorizes LPI across the entire 6 GHz band, there will be up to seven 160 megahertz channels and/or fourteen 80 megahertz channels. The dramatic increase in the number of high throughput Wi-Fi channels would be a game changer in terms of the types of applications and on-line services that can be supported. The significant increase in spectrum for consumer Wi-Fi use will accelerate the development and commercialization of the LPI ecosystem and provide incentives for investment in new devices, applications, and on-line services that can leverage this additional capacity.

A. U-NII-6 and U-NII-8 Bands

Microsoft supports the Commission's proposal to allow unlicensed LPI devices to operate in the 6425 - 6525 MHz (U-NII-6) and 6875 - 7125 MHz (U-NII-8) bands subject to the two specific conditions set forth in the NPRM.[8] We agree with the Commission that LPI devices can share the U-NII-6 and U-NII-8 bands with the incumbents' services without causing harmful interference.

The U-NII-6 band has a spectrum allocation for the mobile service and the Fixed-Satellite Service ("FSS") (earth-to-space), but not for the Fixed Service ("FS"). The Commission stated that it believes that standard-power access points operating outdoors will not cause harmful interference to incumbent FSS operations.[9] By extension, LPI devices operating at several dB in radiated power below standard-power access points should not cause harmful interference to FSS uplinks.

The U-NII-6 band is used by broadcast stations, programming networks, and video production companies for electronics news gathering and wireless video links.[10] Appendix A to the NPRM lists the incumbent services licensed in each of the proposed 6 GHz U-NII bands and the number of incumbent call signs for each service.[11] All but one of the 138 BAS incumbent call signs are for TV Pickup service, whereby a temporary-fixed transmitter operating in a truck ("news truck") relays signals from a remote location back to the studio.[12] To avoid having to obtain prior Commission approval, the transmitting antenna on news trucks must operate at20

[8] *See* NPRM at ¶ 59. The conditions are "(1) unlicensed devices are limited to the lower power levels applicable to unlicensed operations in the U-NII-2 bands and (2) such devices are restricted to indoor operation."

[9] Id. at ¶ 24.

[10] *See* id. at ¶ 60.

[11] Id. at Appendix A.

[12] Id. at Appendix A.

feet or less above ground level.[13] Our presumption is that most transmitting antennas will operate at or below the 20 foot threshold. The typical uplink path then is from 20 feet or less above ground level to a FS receiver located on a rooftop or other structure.

The RKF Study included an assessment of the risk of harmful interference between BAS links and radio local area networks ("RLANs").[14] It is important to note that the RKF Study assumed that RLANs operated both indoors and outdoors, at power levels higher than what the Commission has proposed for LPI devices, and did not take into account building and clutter losses.[15] Using these assumptions, the RKF Study demonstrated that there is a very small (but non-zero) probability of harmful interference.[16] Our expectation is that if only LPI devices were modeled, and building and clutter loss accounted for, the small probability of harmful interference would be further reduced.

Microsoft submits that the simplest, lowest cost, and most obvious mitigation approach is for the BAS news truck operator to take the same actions as when finding a good location at which to establish a mobile link – increase power up to the limit, increase antenna height up to the limit, or move the news truck to a new location within the local area where the signal is stronger. The Commission appears comfortable with this approach.

> Given the uncertainties inherent in establishing mobile links and the attenuation of the signals due to building and clutter losses, we anticipate that low-power indoor operation will not increase the risk of harmful interference to mobile service incumbents.[17]

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[13] *See* 47 CFR § 74.631(a) ("prior Commission authority shall be obtained if the transmitting antenna to be installed will increase the height of any natural formation or man-made structure by more than 6.1 meters (20 feet)."

[14] Apple Inc., Broadcom Corporation, *et al.*, Jan. 25, 2018 *Ex Parte*, Frequency Sharing for Radio Local Area Networks in the 6 GHz Band, January 2018 ("RKF Study") at 54 – 60.

[15] Id. at 12 – 25.

[16] Id. at 59.

[17] NPRM at ¶ 63.

The U-NII-8 band (6875 - 7125 MHz) is allocated to mobile service, Fixed Service and FSS (earth-to-space) (space-to-earth). Appendix A to the NPRM lists the number of incumbent call signs for each service operating in the U-NII-8 band. Wireless microphones operating in the low power auxiliary service ("LPAS") are authorized to operate on the lowermost and uppermost 25 megahertz of the band.

The same analysis for protecting the mobile service from LPI devices in the U-NII-6 band applies to the U-NII-8 band. Likewise, the assessment that RLAN devices will not harm FSS uplinks in the U-NII-6 band also applies to the U-NII-8 band. If the Commission were to issue licenses under the FSS downlink allocation in the future, protecting receive earth stations from LPI devices is a well understood process.

Within the U-NII-8 band, FS links cannot intersect with the service areas of TV pick-up stations, limiting them to certain sub-bands and to less densely populated areas.[18] In these less densely populated areas, LPI devices will likely be in single family homes or commercial structures of modest height. By contrast, the FS links will likely be mounted considerably higher. Taking building and clutter losses into account, the risk of interference from LPI devices to FS links in these locales is very low.

Microsoft could only identify one LPAS licensee in the U-NII-8 band.[19] We are not aware of any commercial wireless microphone models that operate in the band. In the future, if there are licensed LPAS microphones operating indoors, we believe that the venue operator can centrally manage the radiofrequency environment, including Wi-Fi access points operating in the U-NII-8 band, so that LPI devices will not cause harmful interference to LPAS microphones.

[18] *See* NPRM at ¶ 60.

[19] Call sign WRBZ429, licensed to Munchkinland Productions (a national license for multiple frequency bands including 6875 - 6900 MHz.)

Such an approach would not be unduly burdensome on the venue operator and can be implemented through software.

B. U-NII-5 and U-NII-7 Bands

The Commission should also authorize LPI devices to operate in the U-NII-5 and U-NII-7 bands. As a starting point, the probability that a standard-power RLAN access point will cause harmful interference to a FS link is extremely small. Using a highly conservative interference threshold, the RKF Study showed that nationwide operation of standard-power RLAN devices, operating both indoors and outdoors, would result in less than 0.2 percent of the FS links receiving a signal strong enough to cause interference to the FS receiver.[20] The RKF Study included outdoor RLANs operating up to 4 W EIRP and considered indoor RLAN power levels higher than what the Commission proposes for LPI devices.[21] Additionally, the RKF Study did not account for clutter losses that will reduce any LPI device emissions at the FS receiver.

Taking into account lower power levels, loss mechanisms, various mismatches between the LPI device and FS receiver, and how real-world FS links are designed, it becomes clear that LPI devices operating in the U-NII-5 and U-NII-7 bands would not increase the risk to incumbent FS operations. The loss mechanisms include building and clutter loss. The Commission notes that ITU models show "median building entry losses of approximately 18 dB for traditional construction and 30 dB for thermally efficient construction for horizontal incidence, with increasing building entry losses at larger elevation angles."[22] Additionally, the relatively high path loss at 6 GHz becomes significant in the rare situations where the LPI device's signal may be on-axis to a FS receiver, but located tens of kilometers away.

[20] RKF Study at 53.

[21] Id. at 14 and 23.

[22] NPRM at ¶ 70.

The ‘mismatches’ include polarization, frequency overlap, and geometric overlap between the LPI device’s direction of peak gain and the RF receiver. The power reduction in the LPI device signal received by the FS receiver due to polarization mismatch is well understood.

The 6 GHz band will support multiple 80 and 160 megahertz channels. There is a distribution of FS link bandwidths operating in the U-NII-5 and U-NII-7 bands. Only the power in a LPI device’s presumably 80 or 160 megahertz wide channel that overlaps with the narrower FS receiver bandwidth would have any potential impact. As a result, there will often be a frequency mismatch, causing much of the received power to be out of band.

The final mismatch is angular. Angular mismatch reduces geometric overlap between the LPI device’s radiated beam and the effective boresight of the FS receiver. The FS receiver’s off-axis rejection increases significantly a degree or two from boresight. The key parameters are the separation distance between the LPI device and FS receiver, and the elevation and azimuth angles of the LPI device’s transmission. There will be angular mismatch in the vast majority of circumstances.

Microsoft expects the existing deployment practices for consumer and enterprise 5 GHz access points to extend to the 6 GHz band. Enterprise LPI access points will typically be ceiling mounted, with peak gain directed forward and downward. Consumer LPI access points will typically be placed on the floor, table, or shelf, with peak gain directed upward but more omnidirectional. Enterprise LPI access points will be installed in buildings that range in height, while the vast majority of consumer LPI access points will be used near ground level. Even without taking into account obstructions and building loss, the likelihood that either an enterprise or consumer LPI device would impact a FS receiver is very low, because a measurable risk of interference arises only if the LPI device operates within certain very narrow elevation and

azimuth angles. If either angle is even slightly off, the amount of power from the LPI device reaching the FS receiver will be less than would be predicted. In sum, and as described in the 6 USC Comments, common practices used in the deployment of real-world FS links minimize the possibility that a link will pass near buildings, making the possibility of harmful interference from LPI devices even more unlikely.

III. LPI CLIENT DEVICES SHOULD BE PERMITTED TO OPERATE AT THE SAME MAXIMUM POWER LEVEL AS THE CONTROLLING ACCESS POINT

The Commission proposes that LPI client devices be under the control of the access point.[23] Although this restriction would preclude direct device-to-device communication in the 6 GHz band, Microsoft concurs that initially it makes sense for all LPI client devices to be under the control of their respective access points. This restriction will provide incumbent operators with greater confidence that they will be protected from harmful interference.

Microsoft disagrees with the Commission's proposal to limit the power of an LPI client device to 63 mW.[24] Instead, the Commission should permit client devices to operate at the same power level as the controlling LPI access point. This will not increase the risk of harmful interference.

As with 5 GHz Wi-Fi client devices today, there will be both stationary and portable LPI client devices. Stationary LPI client devices will be integrated into home appliances and home entertainment centers – objects that operate indoors. The same loss mechanisms and mismatches that protect incumbent users from the LPI access points will likewise protect incumbents from stationary LPI client devices.

[23] *See* NPRM at ¶ 20.

[24] *See* proposed Section 15.407(a)(6).

Portable LPI clients will be both nomadic and mobile, with the latter likely to cause the greatest concern regarding potential interference. Again, using existing commercial Wi-Fi mobile client devices as an example, the 6 GHz mobile LPI client devices will be battery-powered and handheld. Due to design constraints, operational issues, and RF safety requirements applicable to hand-held devices, Wi-Fi mobile client devices operate below maximum power levels. 6 GHz client devices will face the same power level constraints as 5 GHz client devices. Additionally, handheld mobile LPI client devices will experience body loss, further reducing the risk of harmful interference.

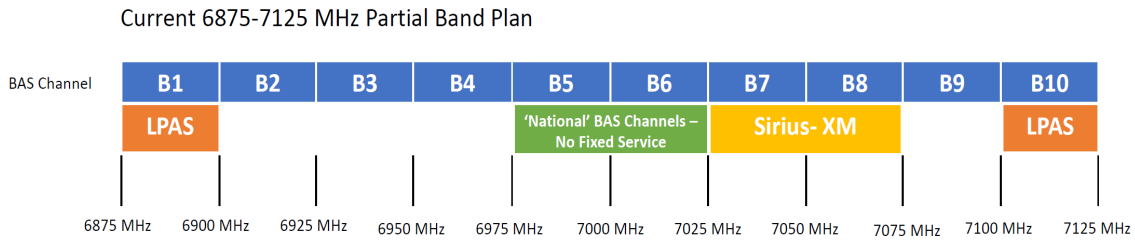
When Microsoft and other members of 6USC examined potential spectrum bands that could be used for Wi-Fi, one important criterion was the ability of the Wi-Fi signal to penetrate one, and ideally two walls at the authorized power level. This consideration applies to both enterprise environments (offices and factory floors) and residences. The Commission's proposal to limit LPI client devices to a lower power than LPI access points would create a situation where a LPI client can receive a strong LPI access point signal, but the weak signal received by the LPI access point from the LPI client will result in data being delivered at a much lower rate, if at all. While the Commission's proposed power limits, and resulting throughput asymmetry, may suffice for the majority today's bandwidth intensive applications, such as consumer video streaming, it will not be sufficient for emerging applications in augmented reality and machine vision. As a result, the useful coverage area of any access point will be substantially reduced for these applications, thereby requiring more access points to be deployed to cover the same area and significantly increasing the cost of deployment. In effect, rather than the Commission authorizing LPI access points at a maximum power of 250 mW (the U-NII-2C level), the actual power levels will be much less – closer to the client LPI maximum. For this reason, Microsoft

urges the Commission to authorize LPI clients at the same maximum power level as LPI access points – 250 mW.

IV. STANDARD POWER ACCESS POINTS SHOULD BE AUTHORIZED IN THE LOWER 100 MHZ OF THE U-NII-8 BAND OUTSIDE OF THE AREAS LICENSED FOR BAS AND CARS

The 6 GHz band has the potential to support multiple contiguous large bandwidth 80 and 160 megahertz wide channels for standard-power and LPI Wi-Fi. While there is a proposed channel plan (which has yet to be adopted by industry), it remains unclear where the lower edge of the 6 GHz band will ultimately start. This will depend on the size of the guard band between the U-NII-4 band and the U-NII-5 band. Given the uncertainty over how and when the Commission will resolve the outstanding 5.9 GHz band issues, Microsoft seeks to ensure that whatever guard band is ultimately adopted does not result in the loss of a potential 80 or 160 megahertz channel at the upper end of the range where standard-power access points can operate.

Consequently, Microsoft proposes that the Commission authorize standard-power access points to operate in the lower 100 megahertz of the U-NII-8 band (6875 - 6975 MHz) outside of the areas licensed for BAS and CARS.



In the drawing above, B1 through B10 represent the 25 megahertz channels used for BAS.[25] CARS uses the same channelization plan as BAS. In 2015, the Commission authorized licensed

[25] BAS channels can also be 12.5 MHz wide.

LPAS microphones to operate in the frequency bands 6875 - 6900 MHz and 7100 - 7125 MHz bands.[26] To the best of Microsoft's knowledge, there are no licensed LPAS microphones operating in the 6875 - 6900 MHz band.

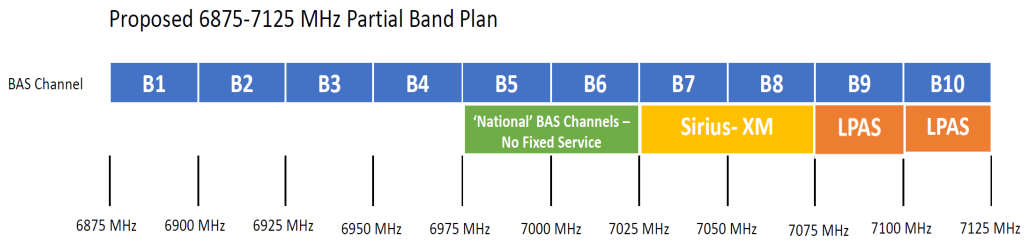
In August 2011, the Commission amended its Part 101 rules to facilitate the use of the 6875 - 7125 MHz frequency range for fixed wireless backhaul for broadband.[27] The conditions placed on the fixed wireless backhaul were that it operate outside of areas licensed to BAS/CARS and that it not operate on channels B5 and B6, which are essentially national channels for any broadcaster to operate BAS outside of its licensed area.

Appendix A to the NPRM lists other incumbent services licensed in the U-NII-8 band: some fixed; some mobile; and satellite, including Sirius XM, operating in the 7025 - 7075 MHz band. For the Commission to make available the lower 100 megahertz in the U-NII-8 band for use by standard-power access points under AFC control outside of areas where BAS and CARS are licensed, it needs to take the following regulatory steps:

(1) Move the lower LPAS channel in the U-NII-8 band from 6875 - 6900 MHz to 7075 - 7100 MHz, as shown in the drawing below. Microsoft believes such action would not place a burden on wireless microphone manufacturers or users because there are no LPAS devices currently operating in this frequency range and the proposed range is adjacent to the upper LPAS channel. Second, placement of the LPAS channel at 7075 - 7100 MHz will avoid the 7025 – 7075 MHz band used by Sirius XM.

[26] *Promoting Spectrum Access for Wireless Microphones*, Report and Order, FCC 15-100 (2015) at ¶ 131.

[27] See *In the Matter of the Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul and Other Uses and to Provide Additional Flexibility to Broadcast Auxiliary Services and Operational Fixed Microwave Licenses*, Report and Order, 26 FCC Rcd 11614 at ¶ 10 (2011).



(2) Under §101.805 of the Commission's rules, assignment of frequencies to mobile stations in the Local Television Transmission Service ("LTTS") will not be limited to a single licensee within any area. However, geographical limits within which mobile units may operate may be imposed by the Commission. Some LTTS licenses are nationwide, while others are statewide or local. Microsoft proposes that the Commission either restrict LTTS station operations to frequencies above 6975 MHz or limit LTTS operations between 6875 - 6975 MHz to areas where there is an active BAS and/or CARS licensee. Appendix A indicates there are currently 37 incumbent LTTS call signs authorized to operate in the U-NII-8 band. On balance, we believe it is in the public interest for the Commission to implement geographic limits on LTTS licensees operating in the lower 100 megahertz of the U-NII-8 band to enable the maximum number of 80 and 160 megahertz wide channels for standard-power access points.

(3) The AFC will ensure that the standard-power access points will not operate within the coverage area of BAS and CARS licensees operating in the lower 100 megahertz of the U-NII-8 band.

(4) The AFC will protect licensed FS links operating outside BAS/CARS license areas using the same methods employed for protecting FS links operating in the U-NII-5 and U-NII-7 frequency bands.

V. THE COMMISSION SHOULD GRANT FLEXIBILITY IN THE IMPLEMENTATION OF AUTOMATED FREQUENCY COORDINATION AS LONG AS INCUMBENT OPERATIONS ARE PROTECTED

Microsoft strongly supports the Commission's proposal to authorize standard-power access points to operate in the U-NII-5 and U-NII-7 bands.[28] Microsoft also supports standard-power access points in the lower 100 megahertz of the U-NII-8 band. Standard-power operations would be subject to Automated Frequency Coordination ("AFC"). Our experience

[28] NPRM at ¶ 74.

with TV White Space databases gives us great confidence that use of an AFC will be successful in protecting incumbents in the U-NII-5, U-NII-7, and U-NII-8 bands, particularly because there are fewer incumbent operations that require protection than in the broadcast TV bands, and because all the required incumbent data is stored in the Commission's database – and that data changes infrequently.

Although there are specific provisions of the White Space Device ("WSD") and Citizen Broadband Radio Service ("CBRS") rules relevant to the AFC, there are significant enough differences such that the Commission should not consider wholesale adoption of either the WSD database or Spectrum Access System ("SAS") model for the 6 GHz band. Microsoft wholeheartedly agrees with the Commission that the AFC requirement should result in a simple database that is easy to implement.[29] Ideally, AFC operation will be transparent to the 6 GHz standard-power access point user.

Having learned from the collective experience of WSD database administrators, Microsoft submits that there is a need for multiple AFC business models. For these reasons, Microsoft supports the Commission defining the interference protection and certification requirements so long as the Commission also allows maximum flexibility in how AFC Operators and AFC Administrators meet these requirements. We are also in favor of the Commission's general approach, adopted from WSD and CBRS rules, in which a standard-power access point incorporating capability that enables more accurate knowledge of its position in two or three dimensions may access more frequencies at its location and/or operate at a higher power level on each available frequency.

[29] Id. at ¶ 25.

A. High Level Definitions for AFC

The Commission proposes to define *Automated Frequency Coordination (AFC)* as "a system that automatically determines and provides lists of which frequencies are available for use by access points operating in the 5.925 - 6.425 GHz and 6.525 - 6.875 GHz bands."[30] Microsoft believes that the Commission is taking the right approach in calling the AFC a system and not prescribing the next level of detail of how the system will work. We propose that the AFC should also be allowed to provide a maximum radiated power available in a given channel. The definition would read, "*Automated Frequency Coordination (AFC)* is a system that automatically determines and provides lists of which frequencies are available for use by access points operating in the 5.925 - 6.425 GHz and 6.525 - 6.975 GHz bands, and the maximum power available at each frequency."

Microsoft sees the basic building blocks of an AFC consisting of a data repository and a calculation engine. The location of the data repository function – whether built into the standard-power access point, stored in a local database, or stored in the cloud, for example – does not matter. What does matter is that the incumbent information is accurate, regularly updated, and secured from unauthorized access and tampering. Similarly, it should not matter where the calculation engine function is performed or how it is performed. The calculation engine function could be performed on the device or in the cloud. The function could be performed by the same entity that performs the data repository function, or by a different entity, or across multiple entities. What is essential, though, is that the calculation engine always provides the correct answer in terms of available frequencies and maximum available power at each available frequency in order to protect the incumbent services.

[30] *See* proposed Section 15.403(b)

The complexity of the calculation engines can and should be allowed to vary greatly based on different use cases. For a WISP in rural Montana that needs to find one or two channels in a given geographic area, a simple look-up of keyhole keep-out zones on a two dimensional map may be sufficient. By contrast, an urban university campus may need to deploy hundreds of devices that can be placed with very high accuracy. A calculation engine for this application could have access to three-dimensional building plans and construction information, as well as LIDAR data from the surrounding area. For this use case, the calculation engine could compute the optimal placement of each device to maximize spectral efficiency. Both scenarios can meet the needs of the user while protecting incumbents. The difference is that the greater the sophistication, the more spectrum that can be used.

Microsoft urges the Commission to allow both centralized and decentralized AFC models. An example of a decentralized AFC model could be a standard-power access point equipment provider or system integrator providing AFC services for its customers. An example of a centralized AFC model could be a third-party database / calculation engine that any standard-power access point could contact and receive information regarding the frequencies it (and its associated client devices) can use at that location and the maximum power at each frequency.

Microsoft proposes two related definitions:

- An *AFC Operator* is any entity that operates an AFC.
- An *AFC Administrator* should specifically refer to a third-party provider of AFC services using a centralized model.

The Commission should permit, but not require, AFC Operators and AFC Administrators to charge a fee. If assessed, fees may vary depending on the business model employed. For example, first party providers might build the fee into the equipment price or the price for

systems integration. Third party providers may choose to charge a fee per access point, or per device, on a monthly, annual, or other basis. Of course, an AFC Operator may choose not to charge any fee.

B. The Commission Should Not Impose a Height Limit on Standard-Power Access Points

Microsoft opposes a maximum installation height for outdoor standard-power access points.[31] The height of an outdoor unit should be factored into the calculations made by the AFC system regarding available frequencies and maximum power levels. There is no reason to limit the height of standard-power access points to 30 meters.[32] In many cases, operators may want to deploy standard-power access points on structures, including high-rise buildings, taller than 30 meters.

C. The Commission Should Permit But Not Require Professional Installation

The Commission should permit, but not mandate, professional installation.[33] There are times and places where professional installation may make more sense than automated geolocation or serve as a complement to automated geolocation. For example, professional installation may make more sense for a standard-power access point that is part of an enterprise network than for a standard-power access point used by an individual consumer. If a device is professionally installed, geographic coordinates and height information will be more precise, but the cost will be higher. Microsoft's experience with WSDs is that the current generation of commercial GPS has a measurement-to-measurement variation of +/- 15 meters. For example, in a high-rise building, using a three-dimensional interference protection approach, the standard-

[31] NPRM at ¶ 51 (the NPRM seeks comment on whether to limit the maximum installation height of outdoor standard-power access points, and if so, whether that limit should be 30 meters).

[32] Id.

[33] Id. at ¶ 52.

power access point may be able to operate on more frequencies on more floors with professional installation than with automated geolocation. The determination as to whether to utilize professional installation should be a business decision made by the operator, not a regulatory requirement imposed by the Commission. Microsoft supports an industry-led process to develop professional installer accreditation standards.[34]

D. The Commission Should Not Require an Industry Group to Develop the Details of Most AFC Systems

No coordination across or among AFC Operators is required because each AFC Operator has independent access to the ULS database, which contains all of the data regarding incumbent operations required for the AFC to make its calculations regarding available frequencies and maximum power levels. In effect, the ULS database serves as the synchronization mechanism for all AFC Operators. The AFC is unlike WSD coordinators in this regard, because the latter must address short-term registrations by Electronic News Gathering microphone operations.

For decentralized AFC Operators providing first-party AFC services or operating a proprietary interface between the AFC and standard-power access points, there is no need for any industry group to get engaged. By contrast, for centralized, third-party AFC Operators and AFC Administrators, there will be a need for further industry coordination to develop a common interface between standard power access points and centralized AFCs. Such interfaces could be developed by the Internet Engineering Task Force (IETF) as it did with the Protocol to Access White Spaces (PAWS) or possibly the IEEE 802.11 that develops industry standards for RLANs, among other things.

[34] Id.

E. The Commission Should Require AFC Certification and Certification of Standard-Power Access Points Paired With One or More AFC Systems in Lieu of a Device Registration Requirement

Microsoft recommends that both centralized and decentralized AFCs be certified to ensure that they are able to retrieve data from the ULS and other relevant databases and can accurately determine available frequencies and the maximum allowed power on each frequency. Standard-power access points (and associated client devices) should be certified as any Part 15 device. Finally, a standard-power access point should be certified with its controlling AFC as a pair. As with WSDs, it is important for vendors to demonstrate that access points can communicate and follow the direction of the AFC. A standard-power access point can be certified with multiple AFCs. Microsoft submits that even if a device manufacturer intends to be an AFC Operator for its equipment, it may also want its equipment to be certified with a third-party AFC Administrator offering a centralized model. When a standard-power access point requests a list of available frequencies at its location from an AFC, the AFC must first confirm that the standard-power access point model has been certified with that AFC. Microsoft believes that with such a certification regime in place, combined with the Commission's interference protection criteria and well-reasoned security provisions, there is no need to register individual standard-power access points.

VI. CONCLUSION

For the reasons set forth above, Microsoft urges the Commission to move expeditiously to authorize LPI operations across the entire 6 GHz band; standard-power operations in the U-NII-5 and U-NII-7 bands, and in the lower 100 megahertz of the U-NII-8 band; and an AFC that protects incumbents and provides AFC Operators with the flexibility they need to accommodate

a myriad of anticipated 6 GHz Wi-Fi use cases that leverage the multiple 80 and 160 megahertz channels that will become available, in a manner consistent with Microsoft's Comments.

Respectfully submitted,

MICROSOFT CORPORATION

Paula Boyd, Senior Director
U.S. Government and Regulatory Affairs

Michael Daum
Director, Technology Policy
Privacy and Regulatory Affairs

901 K Street, N.W., 11th Floor
Washington, DC 20001
202-263-5900

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